NEWSLETTER August 2012 DSM2UG

California Department of Water Resources | Delta Modeling Section

Annual Report

Ralph Finch, Senior Engineer WR, DWR

The following are brief summaries of modeling work conducted during 2011, which is presented in the Annual Report.

Chapter 1 – Monitoring Station Locations

The authors compared several lists of purported accurate measurement station locations and conducted field measurements of some sites. The lists were analyzed using ESRI products and a script in ArcPython. This chapter describes and summarizes the analysis.

Chapter 2 – Improved Geometry Interpolation in DSM2-Hydro

This chapter documents modifications to the DSM2 Delta modeling program that improve the model's internal representation of bathymetry under conditions typical of the Sacramento-San Joaquin River Delta. The authors implemented a more accurate channel cross-sectional calculation scheme based on absolute elevation and also increased the density of geometry samples (number of quadrature points) used when calculating integral quantities such as volume.

Chapter 3 – DSM2 Version 8.1 Recalibration

Modifications to the DSM2 program source code that improve channel geometry representation described in Chapter 2 of this report affects results both in DSM2-Hydro and DSM2-Qual. The model has been recalibrated by adjusting Manning's coefficient values in DSM2-Hydro. The recalibrated Hydro results (flow and stage) are very close to the Bay Delta Conservation Plan (BDCP) 2009 Calibration results, although there are significant changes in Manning's coefficient values. Qual was recalibrated in 2011 after changes to improve DSM2-Qual model convergence. Using the recently recalibrated Hydro, we reran the Qual module to check the impacts of the Hydro source code changes and the Hydro recalibration on EC results. The electrical conductivity results are compared with field data and also the 2009 BDCP Calibration results.

Chapter 4 – South Delta Null Zone Study

The State Water Resources Control Board (SWRCB) is in the process of reviewing and updating the 2006 Water Quality Control Plan for the San Francisco Bay/Sacramento-San Joaquin Delta Estuary (Bay-Delta Plan). The review may result in the potential amendments to the South Delta salinity objectives in the Bay-Delta Plan. Under the review process, SWRCB states that poor water circulation (null zones) contributes to bad water quality in the South Delta, and that the Central Valley Project (CVP) and State Water Project (SWP) are responsible for improving the water circulation conditions while raising water stage so that the farmers are able to divert water. The purpose of this study is to analyze through hydrodynamic modeling whether and to what extent CVP and SWP exports and the agricultural temporary barrier actually influence the water levels (stage) and water circulation in South Delta. The purpose of this study is to analyze through hydrodynamic modeling whether and to what extent CVP and SWP exports and the agricultural temporary barrier actually influence the water levels (stage) and water circulation in South Delta.

Chapter 5 – Estimating Delta-wide Bromide Using DSM2-Simulated EC Fingerprints

This chapter compares 6 methods to determine bromide concentrations at select locations in the Sacramento-San Joaquin River Delta (the Delta). The results of the methods are compared to observed grab sample bromide data at those Delta locations. The analysis confirms MWH's conclusion that direct simulation of bromide with DSM2 and the current version of dispersion coefficients is equivalent to estimating bromide based on DSM2-simulated electrical conductivity (EC) and applying multiple linear regressions based on simulated EC fingerprints. However, using observed EC and multiple linear regressions provides significantly better estimates of bromide. Multiple linear regressions based on Delta regions perform nearly as well as site-specific regressions and allow for converting from EC to bromide at nearly any location in the Delta.

Chapter 6 – A Continuous Surface Elevation Map for Modeling

This chapter documents the development of an elevation data set for multidimensional modeling developed under the REALM project, synthesizing LiDAR, single- and multibeam sonar soundings and surveys and integrating them with existing integrated maps that themselves were collated from multiple sources. The result is a continuous surface—terrestrial and water—in meters using the NAVD88 vertical datum. The initial release of this map was in the form of a 10 m Digital Elevation Map (DEM) for the entire Bay-Delta and parts of the coast to the Farallones, supplemented by a 2 m model of the South Delta in a region where the channel features are poorly resolved at 10 m.

Chapter 7 – DSM2-PTM Simulations of Particle Movement

The National Marine Fisheries Service requested the California Department of Water Resources Modeling Support Branch perform a DSM2-PTM modeling study to investigate the impact of various factors on salmon/steelhead migration behaviors in the Sacramento-San Joaquin River Delta. Those factors include San Joaquin River flows, exports from the State Water Project and Central Valley Project, and the Head of Old River Barrier (HORB). The report documents the assumptions, model setups, and simulation results and could be used to help studies on HORB installation/operation and export adaptive management for salmonid outmigration protections.

Recent Progress in Turbidity Modeling with DSM2

Marianne Guerin, Associate, RMA

For the last several years with funding from MWD, RMA has been coordinating with DWR Operations modeling staff and Joel Herr and Scott Scheeder from Systech to produce weekly three-week forecasts of turbidity and hypothetical “delta smelt particle” movement in the Delta using RMA models. The process entailed receiving forecast operations, flow, stage and salinity boundary conditions from DWR and WARMF forecasts of turbidity boundary conditions from Systech, and then translating these time series into RMA models for flow, stage, salinity and turbidity boundary conditions. In addition, as part of the tasks during the wet season of 2011/2012, RMA worked with Systech to improve WARMF’s translation of its’ suspended sediment model output time series into turbidity time series. As the forecasting process is now finely tuned, the goal is to move the turbidity and adult delta smelt forecasting into the DSM2 model suite, and hopefully turn these aspects of the forecasting over to DWR operations modeling staff. In addition, work is being done by Tetra Tech to develop an ANN for Delta turbidity using the DSM2 turbidity model run under historical conditions. Work on translating RMA’s 2-D delta smelt particle tracking algorithm into DSM2’s 1-D formulation is currently on the “To Do” list.

As of this newsletter to achieve these goals, RMA has refined the DSM2 turbidity model using the additional data available since the original calibration and the refined WARMF turbidity calibration. Using the improved turbidity calibration, the DSM2 historical model was run from 1975 - 2011 with the “best available” turbidity boundary conditions – a combination of data, WARMF output and suspended sediment data - in order to supply DSM2 model output to use in ANN turbidity model development. As usual, determining what defined these synthetic turbidity boundary conditions for such a long historical period was a combination of art and science – stay tuned to CWEMF’s 2013 Annual Meeting for details.

DSM2- PTM Sensitivity Study under Various Operations and Hydrology

Yu Zhou, Engineer WR, DWR

The National Marine Fisheries Service (NMFS) requested California Department of Water Resources (DWR) Modeling Support Branch to perform a DSM2-PTM modeling study to investigate the impact of various factors on salmon/steelhead migration behaviors in the Sacramento-San Joaquin River Delta. Those factors include San Joaquin River (SJR) flows, exports from the State Water Project (SWP) and Central Valley Project (CVP), and the Head of Old River Barrier (HORB).

Thirty six hydrodynamic scenarios are used in the study. These hydrodynamic scenarios are grouped into two sets as shown in Table 1. One is based on the ratio of the SJR flow at Vernalis to the export level (IE ratio), and the other is based on different combinations of SJR flow at Vernalis, Old and Middle River flows.

The assumed flow and operations for these scenarios are synthetic but based on Delta historical hydrodynamic record and facilities operations. May–June 2007 was selected as the simulation period and almost all the boundaries (SAC, SJR flows and CVP+SWP exports) are using their average values of this period. In the study, all the south Delta temporary barriers except HORB are in place. Clifton Court Forebay Gates (CLFCT) uses the Priority 3 as its operation schedule.

Table 1. Simulation Hydrodynamic Scenarios (each has 2 scenarios HORB-IN and HORB-OUT)

SJR_IE			**SJR_OMR**		
SJR Flow (cfs)	**IE Ratio**	**Total**	**SJR flow (cfs)**	**OMR (cfs)**	**Total**
1,500	1:1	15 scenarios	1,500	-2,500, -3,500, -5,000	21 scenarios
3,000	1:1, 2:1		3,000	-2,500, -3,500, -5,000	
4,500	2:1, 3:1		6,000	-2,500, -3,500, -5,000	
6,000	3:1, 4:1		12,000 (only HORB-OUT)	-2,500, -3,500, -5,000	
12,000 (only HORB-OUT)	4:1				

Two sets of 'Three Basins' and 'Southern Delta' particle insertion locations are used. The location information is shown in Table 2. For each PTM simulation, 10,000 particles are inserted at a constant rate within the 24 hours at the beginning of the simulation. The length of the simulation period is 45 days. The insertion time is at the midpoint between the neap and spring tides.

Table 2. PTM Particle Insertion Locations and Related Outputs

Scenario	Insertion	DSM2 node	Description	Output group
Three Basins	Mossdale	6	Mossdale	Standard output; SJR junctions output;
	Calaveras	21	San Joaquin River at Calaveras River	
	Rio Vista	351	Rio Vista	
Southern Delta	HOR	48	Just inside Head of Old River	Standard output
	Turner	140	Just inside Turner Cut	
	Columbia	31	Just inside Columbia Cut	
	Mmid	134	Just inside mouth of Middle River	
	Mold	103	Just inside mouth of Old River	
	Jersey	469	San Joaquin River just downstream of Jersey Point	
	3mile	240	Just inside Threemile Slough	

The model outputs and analysis results include: 1) hydrodynamic conditions comparison between OMR and IE ratio; 2) flow splits at San Joaquin River major junctions; 2) 45-days' particle fates at the Delta boundaries; 4) effects of HORB IN vs OUT on particle fate and route selection. Below are two sample figures of hydrodynamic and PTM output.

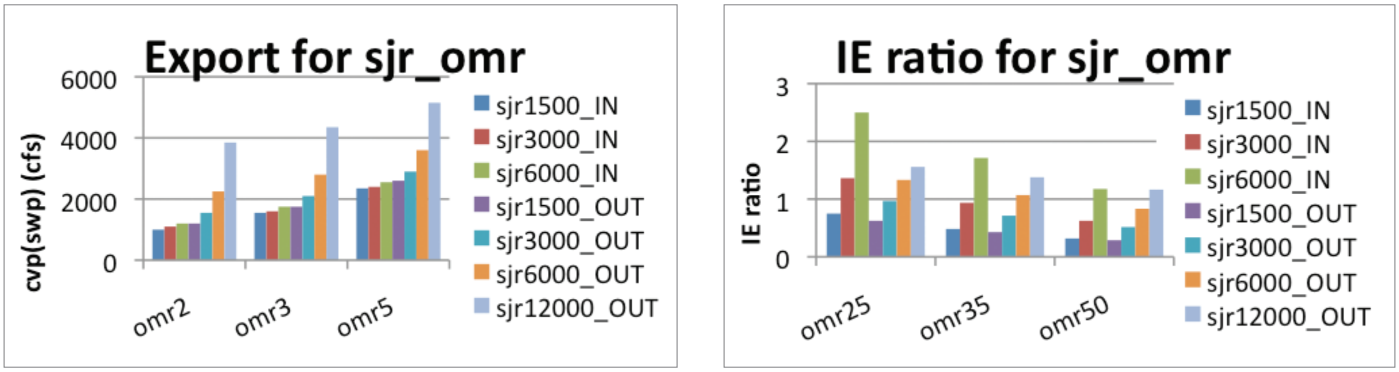


Figure 1. Flow Export and IE Ratios and Their HORB IN&OUT Difference for SJR_OMR Scenarios

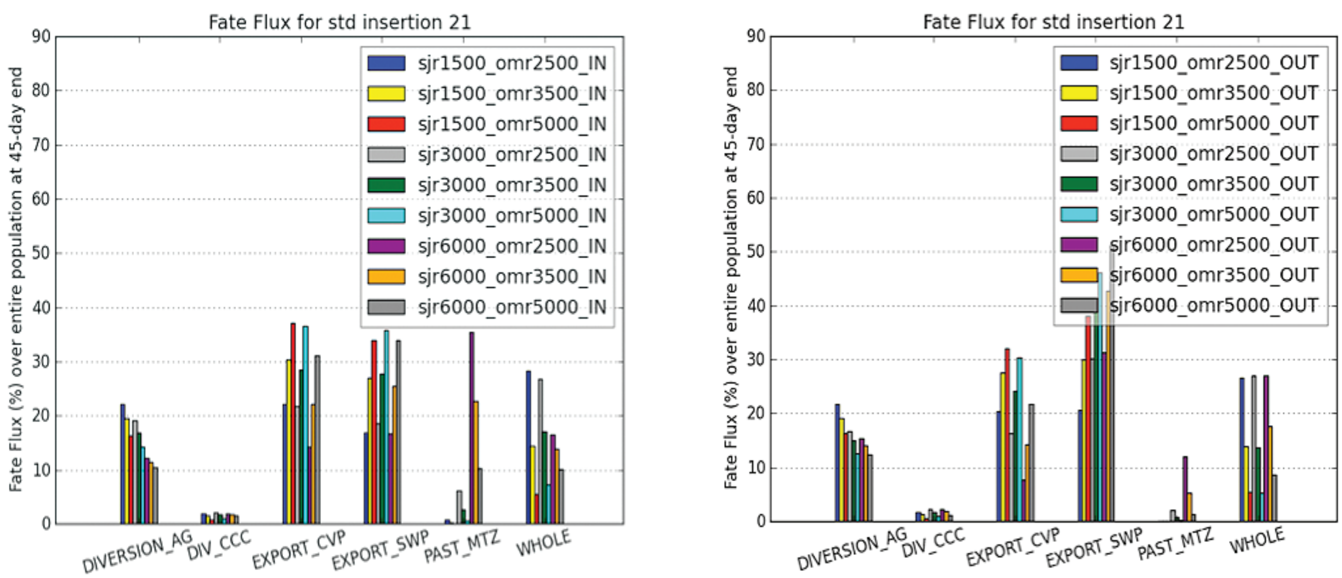


Figure 2. Particle Fates of PTM Standard Outputs at 45-days' End for Scenario SJR1500_

For more detailed information about the study, please refer to the chapter in DWR-BDO annual report 2012.

DSM2 Particle Tracking Model Improvement Update

Xiaochun Wang, Senior Engineer WR, DWR

With the recent biological opinions and court rulings on SWP and CVP export operations, there is an urgent need to develop modeling tools that can be used to evaluate the impacts of various export alternatives and to aid management decision making. In the past, DSM2 Particle Tracking Model (PTM) has been used as a surrogate for fish movement when conducting impact analysis. However, the accuracy of PTM in real-time management decision making may be limited by the discrepancy between particle and fish movement patterns. Therefore, Delta Modeling Section is planning to improve PTM in order to meet management needs. The main improvement efforts will include:

1. *Working with biologists to understand the relationships between Delta hydrodynamics and salmon/steelhead behavior and survival patterns; establish the mathematical formulas for the relationships; implement the mathematical formulas in PTM.*

Over the years, various Juvenile steelhead and Chinook salmon acoustic telemetry tag studies have been conducted and the fish migration and survival data collected. These studies were conducted to improve the understanding of the export operation impacts on the fish's survival during the Delta passage stage of the fish's lifecycle. The PTM group is planning to work with biologists to identify the relationships between Delta hydrodynamics and fish survival using the acoustic telemetry tag study data. If the relationships can be established, mathematical formulas will be developed and implemented in PTM.

2. *Conducting tests on the behavior features currently implemented in PTM and performing sensitivity analysis of the model coefficients:*

The behaviors such as tidal surfing, diurnal migration, falling velocity and mortality have already been implemented in PTM, but the model with the implementations has not been thoroughly tested. Regression and code unit tests will be conducted to make sure that the model behaves as expected. Sensitivity analysis (e.g. model's sensitivity to diffusion coefficients) will also be performed to ensure proper coefficient/parameters selection.

3. *Making PTM more flexible to interface with other lifecycle/hydrodynamic/water quality models:*

More generic interfaces will be developed for PTM to make the model more flexible (e.g., the improved model should be able to obtain fish life cycle/hydrodynamics/water quality information from various other models).

Quantification of Particle Movement under Historical Conditions in the Delta

Chandra Chilmakuri, Water Resources Engineer, CH2M Hill

Freshwater flows and tidal conditions affect the movement of various fish species in the Delta. The passive movement of the Delta's many biological species is primarily influenced by the hydrodynamics in the Delta channels and can be approximated as a function of neutrally buoyant particle movement.

DSM2 Particle Tracking Model (PTM) is a useful tool to perform a quick study of the neutrally buoyant particle movement in the Delta channels under varying flow and tidal conditions. DSM2 PTM uses the cross-sectional and depth-averaged flow field resulting from the DSM2 Hydro module. The one-dimensional DSM2 model has been successfully calibrated and validated for the Delta hydrodynamics using the recent historical observations.
In a recent study, DSM2 PTM was used as the tool to quantify particle movement within the Delta channels under historical flow and tidal conditions. In this study the Delta was divided into several sub-regions and the particle movement from one sub-region to the others is quantified using the DSM2 PTM. The PTM results were used to represent the potential movement of the larval Delta smelt within the Delta channels under historical flow and tidal conditions.

The approach involved identifying the DSM2 channels and open water areas within each sub-region. Using the groups feature of DSM2, the channels and the open water areas were separated into several groups with each group representing a sub-region. Within each group up to six DSM2 nodes were identified for particle release such that the nodes are distributed uniformly across the sub-region. A total of 4000 particles were released in each sub-region over one tidal day (24.75 hours). 4000 particles are uniformly distributed at the identified release locations in each sub-region. For each release period one PTM run was performed for each Delta sub-region, and the particles were tracked for 30 days from the date of release. PTM runs were simulated for 84 periods, starting from 1990 to 2010, for March, April, May and June months in each year. Over 2000 individual PTM simulations were performed in a batch mode.

Historical flows, tides and gate operations were used to drive the DSM2 from 1990 to 2010 period. For the years 1990 to 1999, the 2000 DSM2 calibration run (DSMPWT, 2000) was used to drive the PTM model. For the years 2000 to 2010, the 2009 DSM2 recalibration run (CH2M HILL, 2009) was used. This is because of the Liberty Island flooding that occurred in early 2000, which substantially changed the hydrodynamics in the Delta. The 2000 DSM2 calibration run did not include the Liberty Island flooding while it was included in the 2009 DSM2 recalibration.

The outcome of this analysis was a database of particle movement within the Delta channels under historical flow and tidal conditions. This database provides the percentage of particles ending up in the various sub-regions of the Delta at the end of 30 days from the date of release from one sub-region of the Delta. In addition, the percentage of particles leaving the DSM2 boundary via, exports, diversions and the tidal boundary are reported at the end of 30 days from the date of release. A spreadsheet tool was developed to spatially visualize the results from this PTM analysis. In the near future, this database of the particle movement will be extended to include the results under historical flow and tidal conditions for the years 1975 through 1989.

In conclusion, a database of particle movement within the Delta channels under the historical flow and tidal conditions was developed. This database can be used in several studies that require an understanding of how the historical Delta hydrodynamics influenced the movement and fate of the various plankton and fish species that are critical to the Delta ecosystem.

Advancements with DETAW

Lan Liang, Engineer WR, DWR and Bob Suits, Senior Engineer WR, DWR

The Delta Evapotranspiration of Applied Water (DETAW) Model estimates daily and monthly soil water balances for 168 subareas within the Sacramento-San Joaquin River Delta Region. It accounts for evapotranspiration losses and water contributions from rainfall, seepage and irrigation. Originally written by UC Davis in C++ by UC Davis, DETAW has been rewritten in Python in order to shorten run time and provide the flexibility of output needed to fully implement model results in Delta simulations via DSM2. The Python version of DETAW generates a single DSS file for monthly data and 16 DSS files for daily data.

After the Python version of DETAW was created and tested, adjustments to the crop coefficients assumed in DETAW were calibrated using results from Surface Energy Balance Algorithm for Land (SEBAL) based on 2007 data. SEBAL provides an independent estimate of actual water consumption (actual evapotranspiration ETa) from satellite imaging, proprietary algorithms, and ground truthing. The adjustments to crop coefficients in DETAW have been validated by comparing SEBAL and DETAW modeled 2009 consumptive use. Total Delta consumptive use modeled for 2009 by DETAW and SEBAL match well.

Currently, we have begun documenting DETAW within the scope of a larger technical report. This report will include: the current understanding of consumptive use in the Delta, how DETAW results differ from the results from other DWR models of consumptive use, the impact DETAW-derived consumptive use estimates have on estimated historical Delta outflow, and an analysis of impact of implementing DETAW on DSM2-simulated historical water quality. It is anticipated that using DETAW-generated consumptive use will a recalibration of DSM2 QUAL.

Future work related to DETAW is anticipated to focus on refining and improving how DETAW results are implemented in DSM2. This work will include how diversions and drainage are assigned to DSM2 nodes and the water quality assigned to drainage.

Now Available for DSM2: Updated Representation of 35+ Delta Islands

Ines Ferreira, Engineer WR, DWR and Jamie Anderson, Senior Engineer WR, DWR

The Delta Simulation Model 2 (DSM2) can be used to estimate impacts of flooding Delta islands on water quality. Recently, the representation of many of the Delta islands in DSM2 has been updated to reflect newly available LIDAR based land elevation data. This article provides a brief overview of how DSM2 represents flooded islands and presents the information used to update DSM2's information on 35+ Delta islands.

Flooded islands (and any open water body) can be represented in DSM2 using "reservoirs". DSM2 reservoirs are analogous to tanks with a specified bottom elevation and area and no specified shape (Figure 1). The bottom of the tank is at the average bottom elevation of the island. The area of the tank is the area of the island. Thus DSM2 represents the average volume of the island but does not reflect the island shape or topography. Details about the levees surrounding the island are not represented. To represent an island flooded from a single levee breach, the DSM2 reservoir representing the island is connected to the DSM2 grid at the closest grid node point. For multiple breach locations or to represent a permanently flooded island, the reservoir representing the island can be connected to the DSM2 grid at multiple nodes.

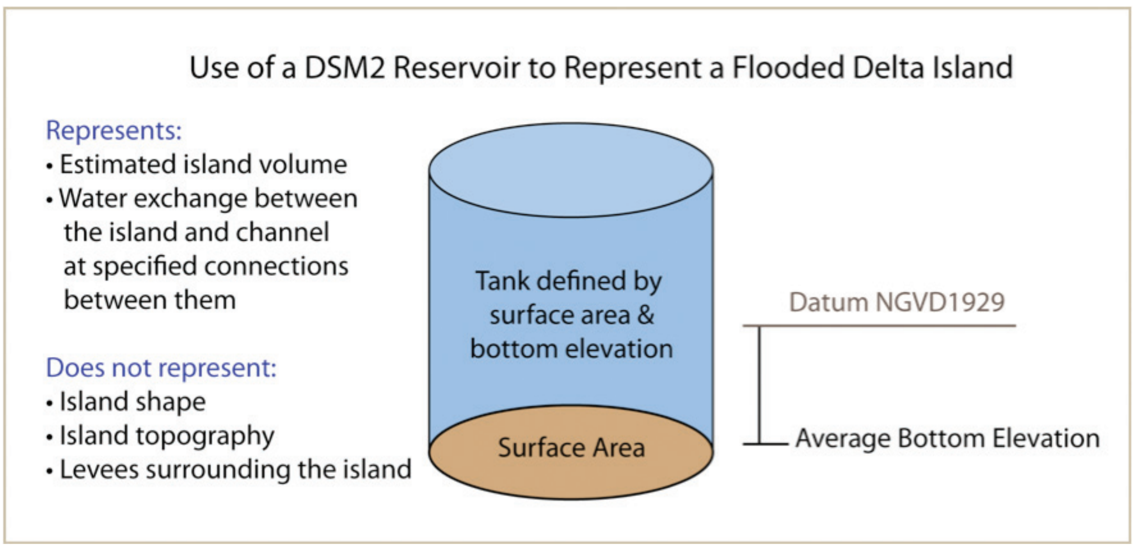


Figure 1: DSM2 Representation Flooded Delta Islands

Recently the representation of over 35 Delta islands has been updated in DSM2 based on newly available topographic data (Figure 3). The new data were collected using a method called LIDAR (Light Detection And Ranging). Airplanes flew over the Delta and used optical remote sensing technology to produces high resolution detailed topographic data for the Delta island land surface (LIDAR can't penetrate water). From the LIDAR data, revised estimates were made of the bottom elevations and surface areas of Delta islands (Table 1 shaded data). This updated data was incorporated into DSM2 for the islands labeled on the map in Figure 2. For further information, please contact Jamie Anderson at jamiea@water.ca.gov

Acknowledgements: The authors would like to thank the following DWR staff for their assistance with this effort: Eli Ateljevich, Joel Dudas, Jeff Galef, John Shu, Amy Simpson, Rueen-Fang Wang, and Jane Schafer-Kramer.

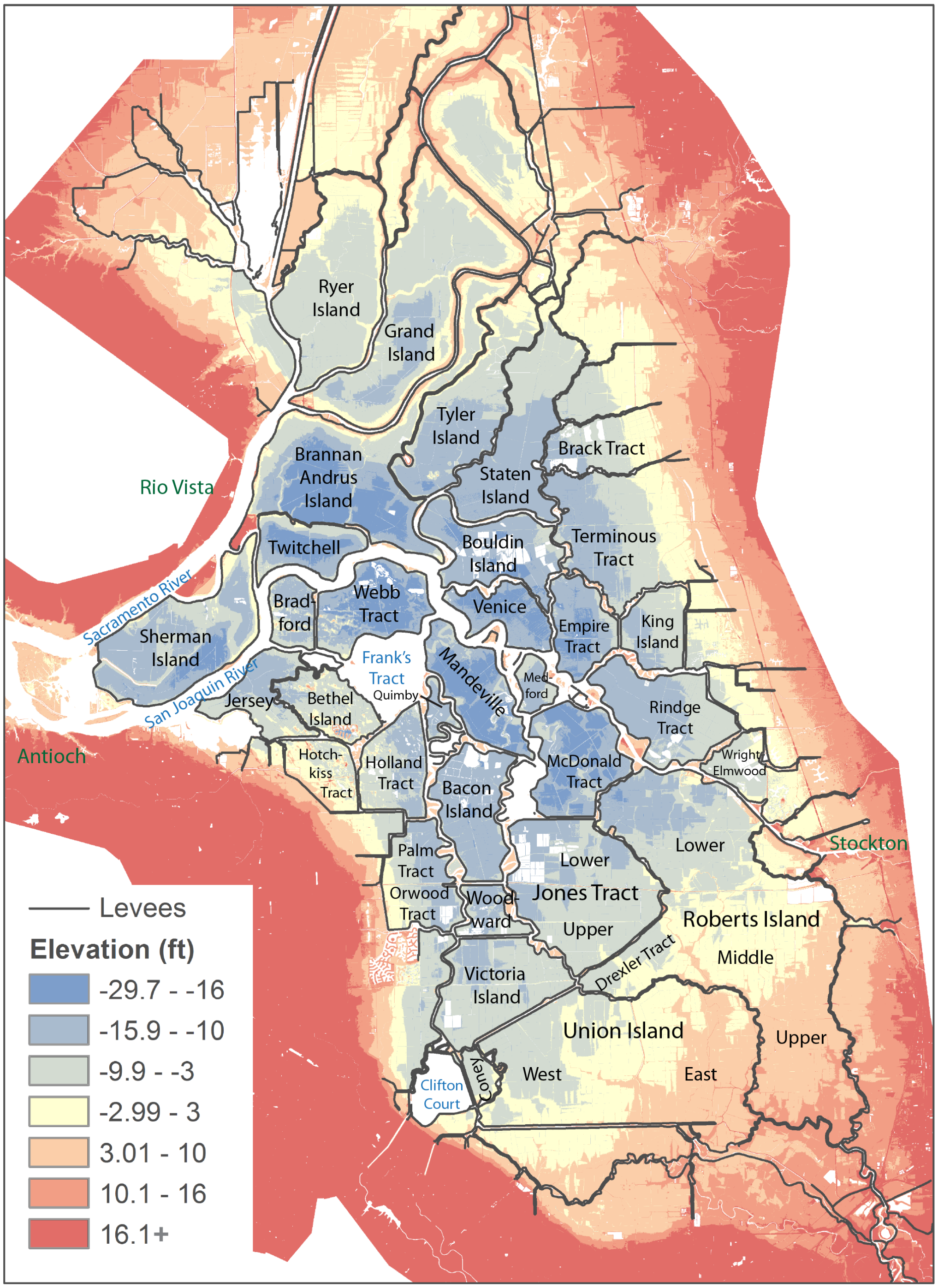


Figure 2: Map of LIDAR based Delta Island Land Elevations (NGVD 1929)
Note: Islands that are labeled have an updated representation in DSM2

Table 1: Delta Island Area and Bottom Elevations Based on LIDAR Data

Area and Mean Bottom Elevation are used in DSM2 to describe each island

	AREA	BOTTOM ELEVATION (ft NGVD29)			
NAME	**(acres)**	**Mean**	**Min**	**Max**	**Range**
BACON ISLAND	5,578	-14.9	-23.0	12.6	35.5
BETHEL ISLAND	3,463	-7.7	-32.5	19.0	51.5
BOULDIN ISLAND	6,027	-15.0	-23.3	17.0	40.4
BRACK TRACT	4,710	-6.0	-17.2	12.8	30.0
BRADFORD ISLAND	2,135	-12.0	-21.7	14.6	36.3
BRANNAN-ANDRUS	12,947	-13.0	-26.9	44.0	70.9
CONEY ISLAND	959	-7.3	-15.1	16.5	31.7
DREXLER TRACT	3,137	-5.4	-14.8	19.4	34.2
EMPIRE TRACT	3,647	-16.5	-25.2	12.0	37.2
GRAND ISLAND	16,870	-6.5	-18.4	30.9	49.4
HOLLAND TRACT	4,310	-10.8	-20.1	13.1	33.2
HOTCHKISS TRACT	2,944	-2.7	-12.4	19.7	32.1
JERSEY ISLAND	3,462	-10.8	-19.5	14.2	33.6
KING ISLAND	3,203	-10.4	-18.6	12.0	30.5
LOWER JONES TRACT	5,719	-11.7	-20.4	15.3	35.7
LOWER ROBERTS ISLAND	10,560	-10.0	-21.7	18.5	40.3
MANDEVILLE ISLAND	5,267	-17.0	-25.4	12.5	37.8
MCDONALD ISLAND	6,042	-16.4	-26.3	13.9	40.2
MEDFORD ISLAND	1,148	-12.3	-16.6	10.3	26.9
MIDDLE ROBERTS ISLAND	11,896	-0.2	-11.8	43.5	55.2
PALM-ORWOOD	4,876	-9.4	-17.1	19.5	36.7
QUIMBY ISLAND	767	-11.7	-18.7	17.8	36.6
RINDGE TRACT	6,716	-12.7	-22.6	14.1	36.6
RYER ISLAND	11,787	-6.4	-16.9	28.0	45.0
SHERMAN ISLAND	10,424	-12.4	-24.4	22.5	47.0
STATEN ISLAND	9,052	-12.8	-19.4	18.3	37.7
TERMINOUS TRACT	12,266	-7.3	-23.5	35.9	59.4
TWITCHELL ISLAND	3,554	-14.7	-25.3	13.0	38.3
TYLER ISLAND	8,811	-10.1	-21.4	19.3	40.8
UNION ISLAND EAST	11,645	2.1	-9.4	29.7	39.1
UNION ISLAND WEST	13,145	-4.7	-15.9	21.8	37.7
UPPER ANDRUS ISLAND	2,322	-2.7	-13.3	22.3	35.6
UPPER JONES TRACT	6,251	-9.7	-20.1	14.2	34.3
UPPER ROBERTS ISLAND	7,519	6.5	-2.7	27.6	30.3
VENICE ISLAND	3,089	-17.7	-23.0	11.4	34.4
VICTORIA ISLAND	7,144	-10.7	-17.7	18.9	36.5
WEBB TRACT	5,422	-16.5	-24.4	11.5	35.9
WOODWARD ISLAND	1,802	-11.8	-17.8	17.2	35.0
WRIGHT-ELMWOOD TRACT	2,096	-6.5	-20.8	25.3	46.1

Updating Clifton Court Gate Ratings and Modeling CCFB Operations

Eli Ateljevich, Engineer WR, DWR and Ming-Yen Tu, Engineer WR, DWR

This is a status update on work to improve estimates of flow through Clifton Court Gates, including a new rating curve for the gates and an updated description of operating strategies. The project thus far has included original data collection and interviews with project managers and field crew.

Clifton Court inflow can be inferred from forebay storage changes and pumping or estimated using a ratings curve. For hypothetical planning scenarios, flow through Clifton Court Gates is usually rated on radial gate heights and water surface differences inside and outside the forebay. Several ratings relationships have been proposed over the years. Delta Field Division assumes a formula based on the 1988 Hills Equations (see the 2004 Delta Modeling Section annual report by Kate Le). The equations in DSM2 are based on a simpler orifice equation. The software capability to incorporate radial gate height into the equations was introduced in version 7.0 -- but despite being heavily requested, the capability was never fully utilized in production.

Also needed for realistic planning is a description of operations. DSM2 modelers and field operators are accustomed to lingo such as Priority 3 or Priority 4 to describe the hours when Clifton Courts radial gates are eligible to be raised. The Priority scheduling system was devised to minimize the impact of the State Water Project on water levels in the South Delta. However, there are differences in the way modelers and operators interpret the Priorities. Most notably, in DSM2 practice the gate is commonly held open for the full eligible period, whereas in the field it is closed when the intake quota for the day is met. During certain parts of the year, operators are also nuanced in the manipulation of gate heights, a strategy called “sipping”. Considerable experimentation has occurred in the years since the Wanger decision, emphasizing fish protection and de-emphasizing electricity prices compared to equipment wear and tear.

Both ratings and gate scheduling represent opportunities for improving DSM2. MacWilliams and Gross noted that the Hills Equations are inaccurate for low-medium flows, having been developed in an era where flows over 10,000 cfs were commonplace. We believe the DSM2 rating is similarly biased towards high flows, although misinterpretation of Priority 3 is probably more important in terms of long term accuracy of water levels and water quality within the forebay. Our report in October, slated for presentation in the DSM2 user group meeting, will discuss operational strategy in more detail and how to use the DSM2 operating rule feature to best represent gate logic in a planning model.

Much of the work on the project date has been data collection. Earlier ratings were hampered in part because they were fit to a narrow range of tide, gate and flow scenarios. The limiting component of the data is usually flow, which has not been monitored continuously in the intake channel and cannot be inferred from storages in sufficient time detail. In order to avoid a lot of extrapolation from one flow regime to another, we are re-rating the gates using existing and new ADCP flow data collections that cover a richer variety of flows, tidal conditions and operational strategies:

1. DWR, 2004-5: calibration data for a (withdrawn) flow monitoring study
2. Ruhl, 2008: a Clifton Court special study funded by DWR and undertaken by USGS.
3. DWR, February 2012: low flow, weak neap tide collection
4. DWR, April 2012: low flow, strong spring tide collection

The data coverage from these deployments is shown in Figure 1 in a matrix plots. This is an array of scatter plots pairing most of the important variables, including gate height, exterior water surface, water surface differences between channel and forebay and observed flows. The axes for each plot can be found by tracing the row and column to the diagonal. In the upper plots, the colors of the points indicate the date of collection. In the lower plots, the colors indicate how fast flow is changing (dQ/dt) which we (probably incorrectly) assumed would be a significant source of error and variability.

From the upper plots of Figure 1, it should be clear why study design is important -- individual outings are not very diverse, and any one or two data collections would cover only a narrow range of flow and tide scenarios.

Figure 1 also shows that gate height is surprisingly dominant in determining flow. We had been considering several forms of ratings equations, including the current DSM2 orifice equation, HECRAS weir and radial gate formulations and the Energy-Momentum method. Our preliminary data analysis suggests that the complexity of these models may be too unjustified. Given the surprising fraction of the variability explained by gate height, we are now pursuing simpler models.

Thanks to Kate Le, Dave Huston and Central District (ADCP collection), Andy Chu, Tracy Hinojosa, Steve Ballard and others who were willing to be interviewed concerning operations and data and helped us accomplish the flow study design which spanned several months.

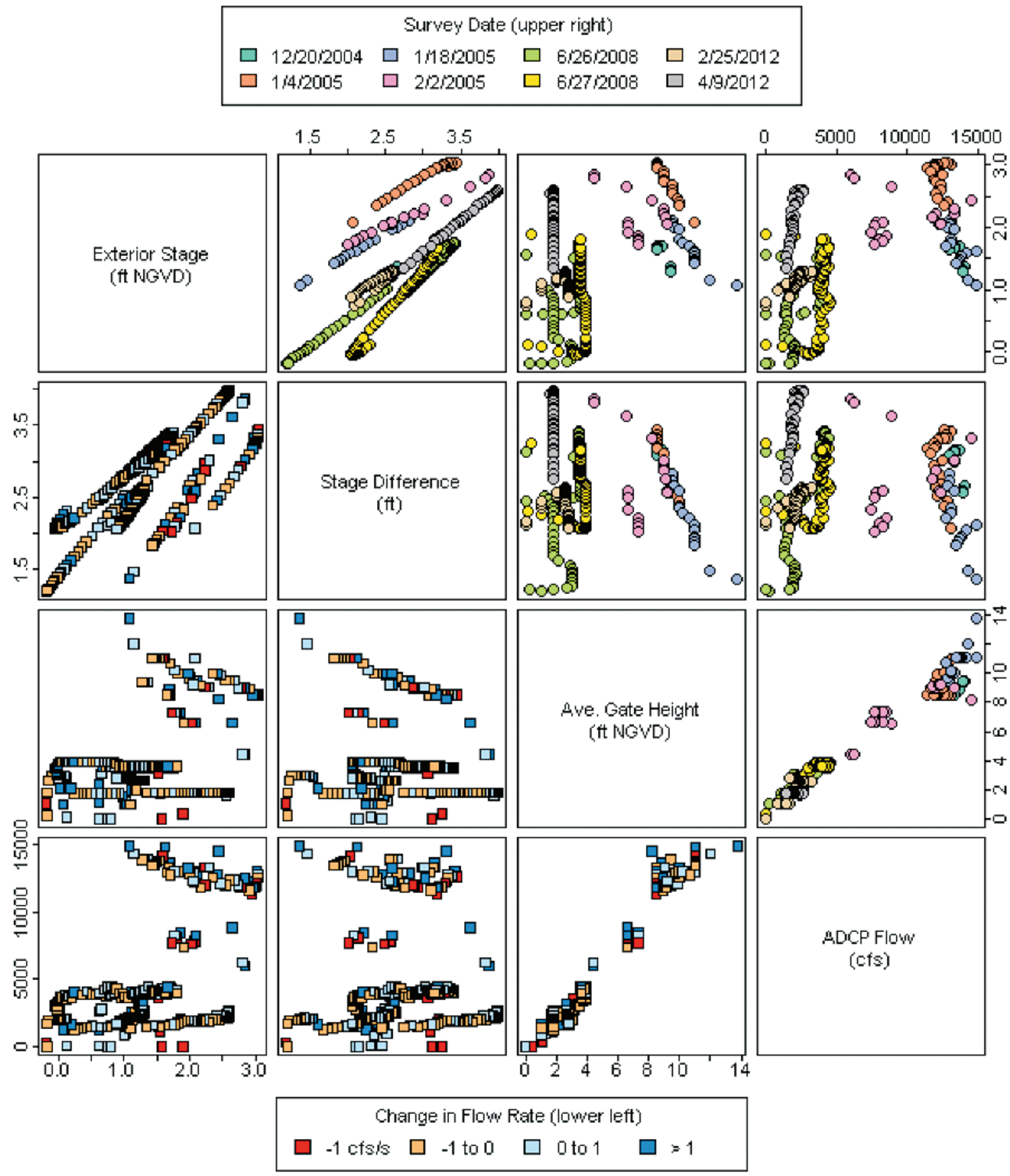


Figure 1: Matrix plot of some of the variables collected during the project. All possible pairs are shown as scatter plots, and the axes for the plots can be discovered by tracing the row and column to the diagonal. Plots above the diagonal are colored by date of collection; plots below the diagonal are colored by the rate of change in flow at the time of collection.

DSM2 Version 8.1 Calibration with NAVD88 Datum

Lianwu Liu, Engineer WR, DWR and Nicky Sandhu, Senior Engineer WR, DWR

Introduction

A new calibration effort has been going on for Version 8.1. The main differences in this new version include: datum conversion to NAVD88; modifications to the DSM2-Hydro program source code that improve channel geometry calculation, presented at CWEMF 2012 conference; DSM2-Qual model formulation change to improve model convergence, which was presented at CWEMF 2011 conference and discussed in Chapter 1 of the 2011 Annual Progress Report; and Martinez EC boundary correction. These changes affect results both in DSM2 Hydro and Qual. This calibration is done mainly by adjusting Manning's coefficient values in Hydro and dispersion coefficients in Qual. Further improvements involving other changes, e.g. new bathymetry and grid change, may come in future releases.

Hydrodynamics Calibration

This calibration is based on the 2009 BDCP Calibration grid (CH2M 2009), and converted to NAVD88. CDEC has been reporting stage data from 2006 in NAVD88. It is more accurate to use NAVD88 and convenient for comparing stage with observed data.

The Hydro calibration period was from 10/1/2001 to 10/1/2002 and 10/1/2007 to 10/1/2008, and validation period from 10/1/2006 to 10/1/2007, and 10/1/2009 to 10/1/2009. The calibration stations are shown in Figure 1.

The model was primarily calibrated to match observed flows. Mainly Manning's coefficients were adjusted for Hydro calibration. Stage was also compared to observed data in the same format as flow comparison. The calibration metrics are composed of five figures for each station:

- **Timeseries comparison of instantaneous flow.** This plot compares modeled and observed instantaneous flow. We show only 5 days in order to be able to see the tidal process and comparison clearly.

- **Timeseries comparison of tidally-filtered daily-averaged flow.** This plot compares modeled and observed tidally averaged flow, or net flow. Net flow is critical for flow distribution and for salt transport.

- **Linear regression analysis of tidally-filtered daily-averaged flow.** This scatter plot with a linear regression trend line shows statistically the comparison of the simulated vs. observed daily averaged flow. R2 value gives information about the goodness of fit of the model. The trend line shows over- or under-predicting of the model.

- **Linear regression analysis of instantaneous flow.** This analysis followed a similar procedure described in the "Flooded Islands Pre-Feasibility Study" report (RMA 2005). The phase difference between the modeled and measured time series was determined using a cross-correlation procedure, and the modeled time series was shifted with the calculated phase lag before doing the regression analysis. The phase difference is noted in the figure. A positive value indicates that the simulated tidal process lags behind the observed record, while a negative value indicates a faster response by the model. The slope of the regression line approximates the amplitude ratio for modeled vs. observed tidal process. R2 value gives information about the goodness of fit of the model. This plot was generated using data from 5/15/2008 to 7/15/2008. This short period of low flow was selected to better represent the tidal process. It is difficult to use the whole calibration period since high flow period may have bigger net flow errors, which may mess up the plot.

- **Daily Maximum, Average, Minimum comparison.** This plot compares modeled and observed daily maximum, average, minimum flow over the entire calibration period. It is easy to see how the model is doing overall in the entire calibration period.

Since overall the calibrated flow in 2009 BDCP Calibration matched observed data reasonably well, the 2009 calibration was used as a reference. Manning's n values were adjusted by groups. 26 runs were made to reach the satisfactory result.

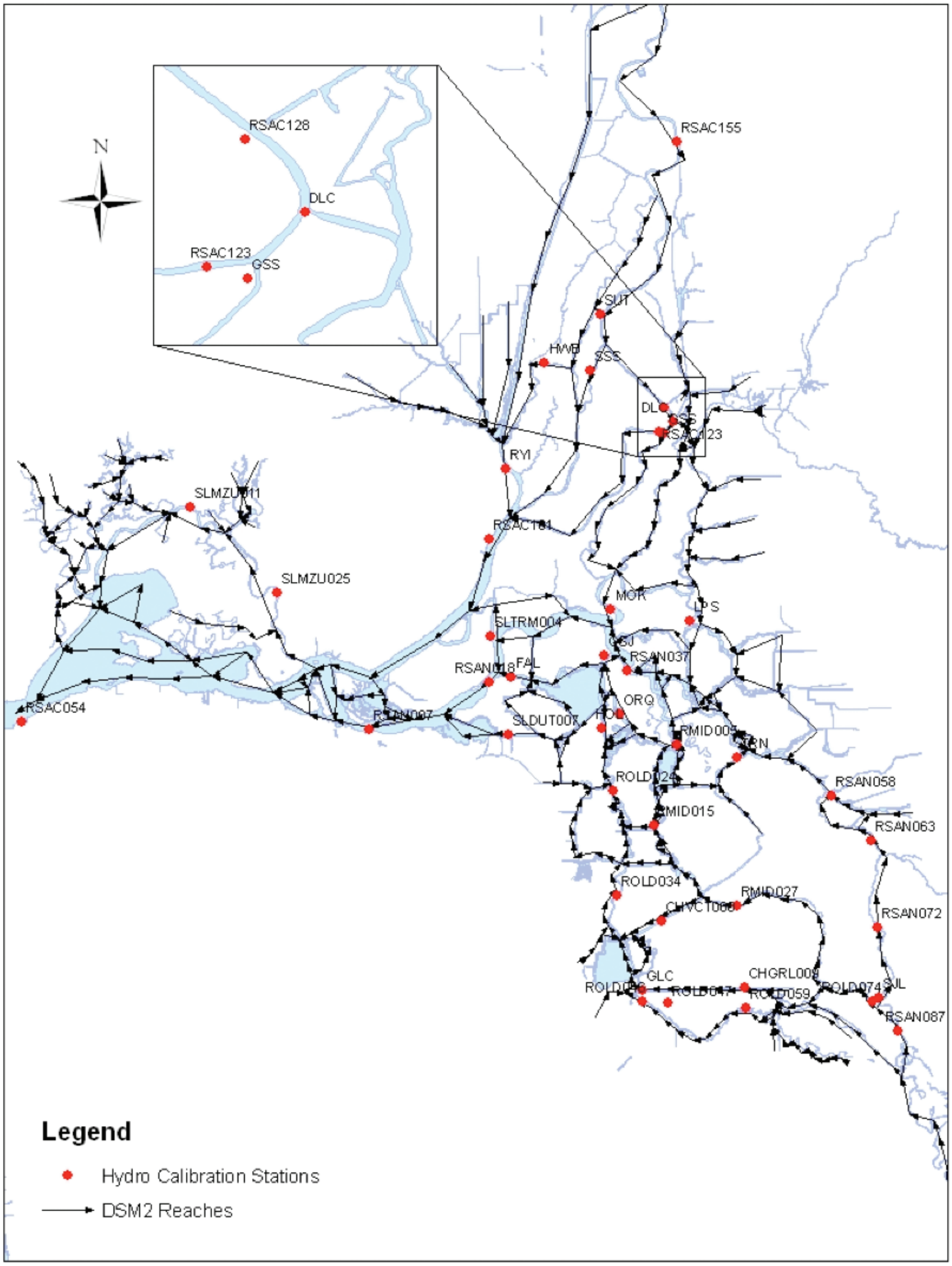


Figure 1. Hydro Calibration Stations

Due to the bug fixes, Manning's n values changed significantly in some areas. For example, in Sutter Slough and Steamboat Slough, Manning's n changed from 0.024 to 0.029; Lower San Joaquin River channels 48 to 51 changed from 0.022 to 0.026; Montezuma Slough area changed from 0.018 to 0.021.

Flow results at a few locations are shown in Figures 2 to 4. In brief summary, stations at North Delta showed moderately improved results comparing to 2009 BDCP Calibration, e.g. RSAC123 (Figure 2). Stations at South Delta showed little improvements, e.g. ROLD024 (Figure 3). A few stations showed dramatic improvements, e.g. RSAN087 (Figure 4).

Simulated stages are compared with field data and also the 2009 calibration results (converted to NAVD88 from model results in NGVD29), e.g. CHGRL009 and DLC (Figure 5 and 6). Maximum stages in tidal cycles match much better with field record. Minimum stages tend to be lower than observed data (Figure 6), as a result, simulated tidal ranges still tend to be larger than field data.

EC Calibration

Version 8.1 improved the dispersion formulation for model convergence, which was described in the Annual Progress Report (Liu & Ateljevich 2011). A new dispersion coefficient (DC) was introduced. The calibration period was from 10/1/2000 to 10/1/2008. This calibration is just started. Since 15 minute EC data at Martinez became available from 2008, we are planning to switch to 15 minute interval for Martinez boundary EC to improve model accuracy.

The metrics used to evaluate model performance include:

- Linear regression analysis of monthly-averaged EC. This scatter plot with a linear regression trend line shows the simulated vs. observed monthly averaged EC. The intercept is set to zero so that the slope shows the bias of the model for higher EC. The model is overpredicting when the slope is higher than 1, and underpredicting when the slope is smaller than 1. R2 value gives information about the goodness of fit of the model. A high R2 value close to 1 means best fit, which usually means high quality data and good model prediction.

- Timeseries comparison of monthly-averaged EC. This plot compares modeled and observed EC month by month, easy to see directly which months the model is doing well or bad.

- Timeseries comparison of daily-averaged EC. This plot compares modeled and observed EC on a daily basis, making it easier to see how the model is doing over all.

- Mean Error (ME) and Percent Mean Error(PME). The mean values of observed and modeled EC for the entire calibration period are calculated. Percent Mean Error is calculated using Mean Error divided by the observed mean. This gives a normalized percentage how much the model is overpredicting or underpredicting.

- Root Mean Squared Error (RMSE) and Relative RMSE. RMSE is calculated based on daily averaged data. It is a good indicator of model prediction error and representative of the size of a "typical" error. The relative RMSE (also called normalized RMSE, or percent RMSE) is calculated as RMSE divided by the range of the data and expressed in percentage.

Summary

The Version 8.1 calibration is still going on. Preliminary results showed moderate improvements in Hydro. Other changes in the model are still needed to further improve the calibration, e.g. improved Franks Tract representation, better bathymetry etc.

Reference

CH2M Hill (2009). DSM2 Recalibration (in Support of Bay Delta Conservation Plan). Prepared for California Department of Water Resources, October 2009.

Lianwu Liu and Eli Ateljevich (2011). Improvements to the DSM2-Qual Part 1. Methodology for Flow and Salinity Estimates in the Sacramento-San Joaquin Delta and Suisun Marsh. 32nd Annual Progress Report, June 2011.

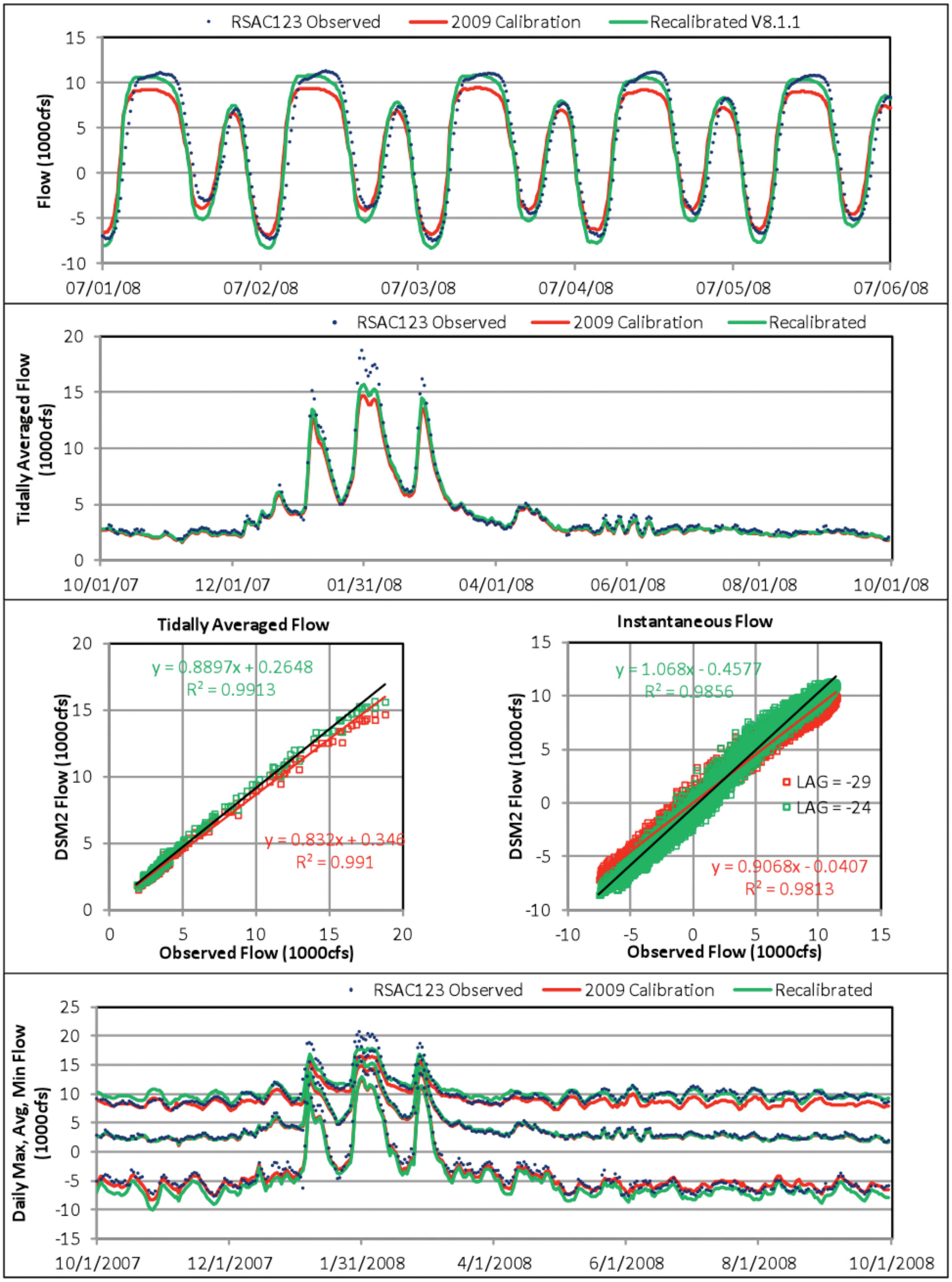


Figure 2. Sacramento River downstream of Georgiana Slough

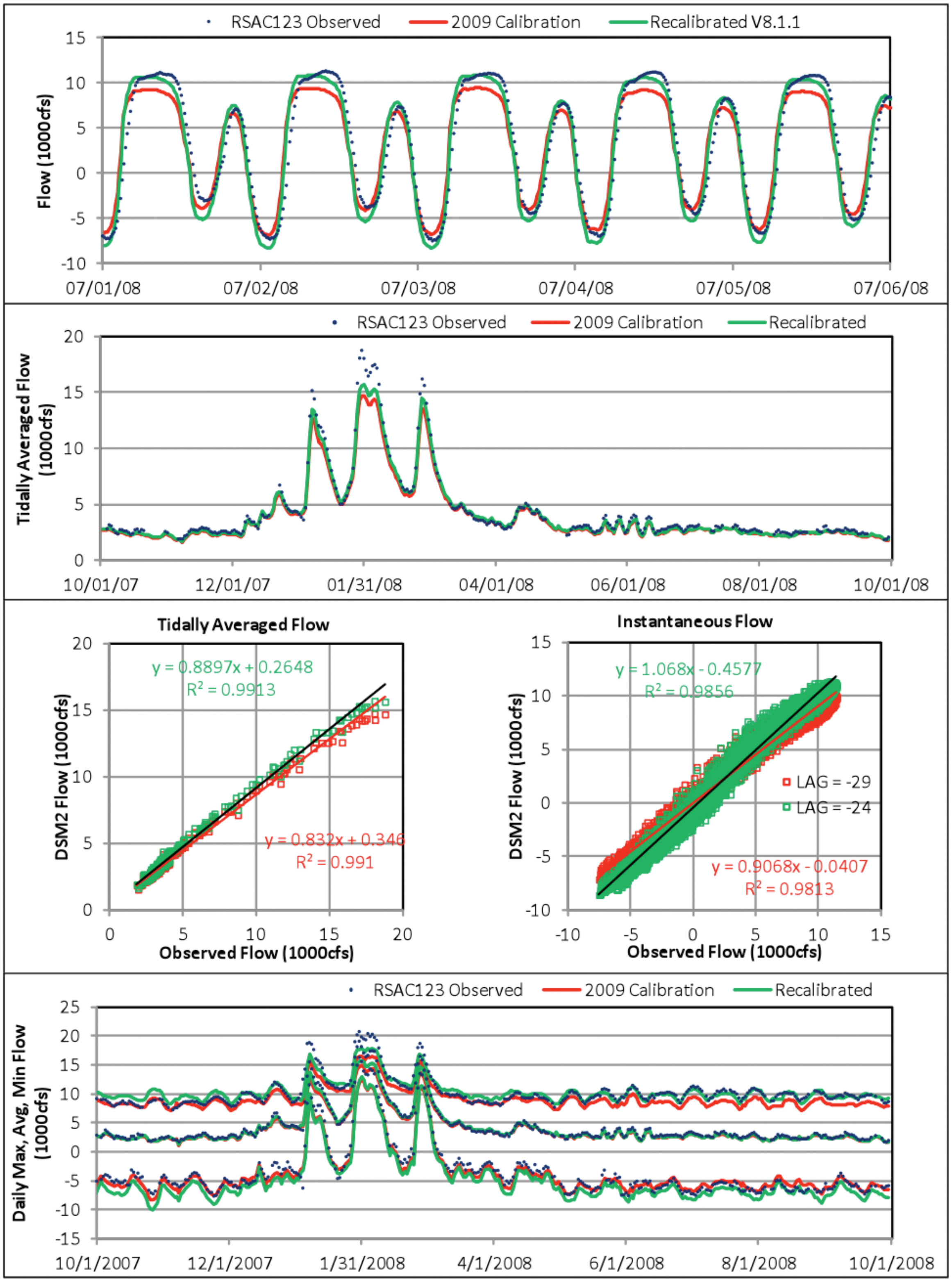


Figure 3. Old River at Bacon Island

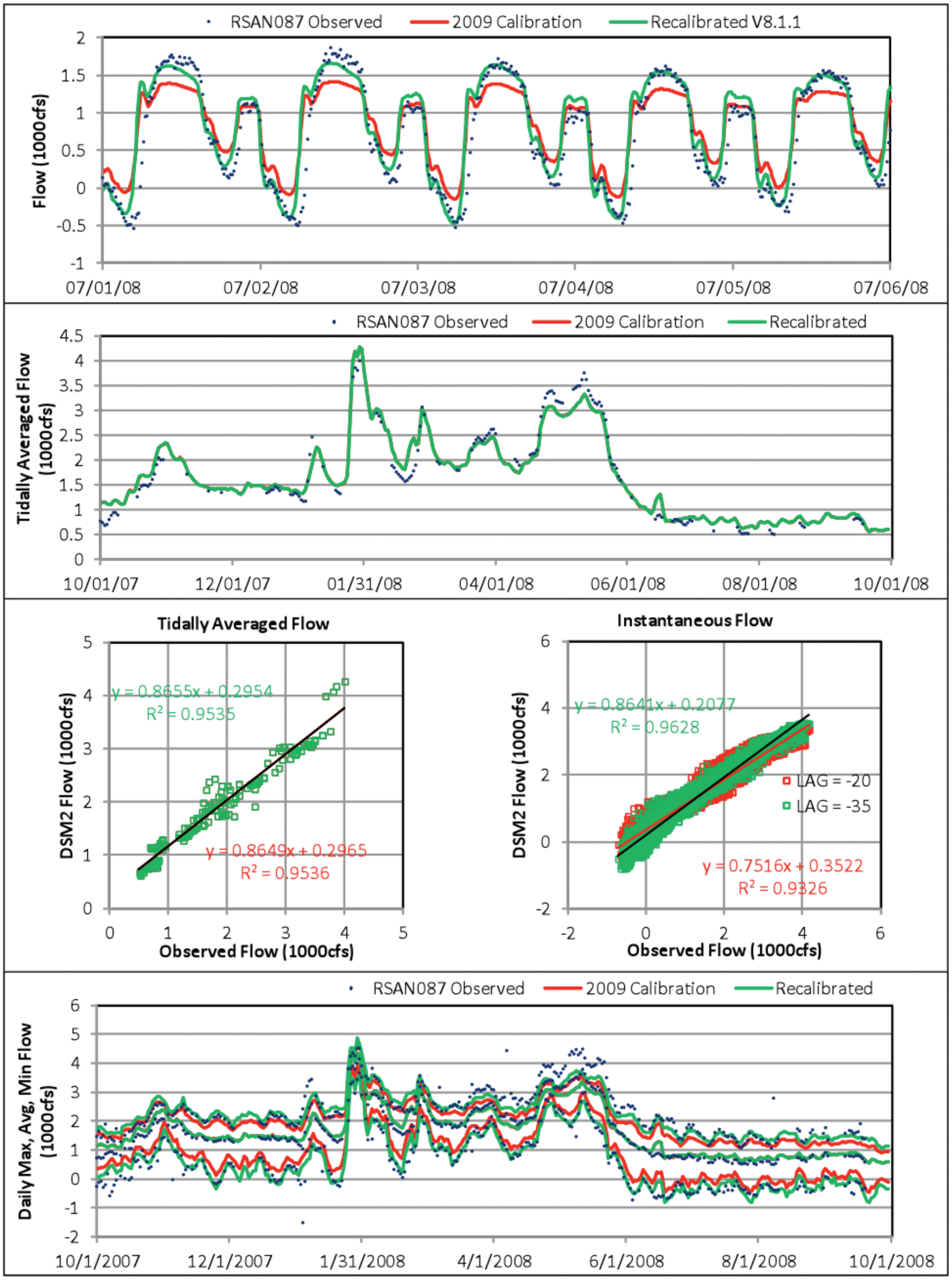


Figure 4. San Joaquin River at Mossdale

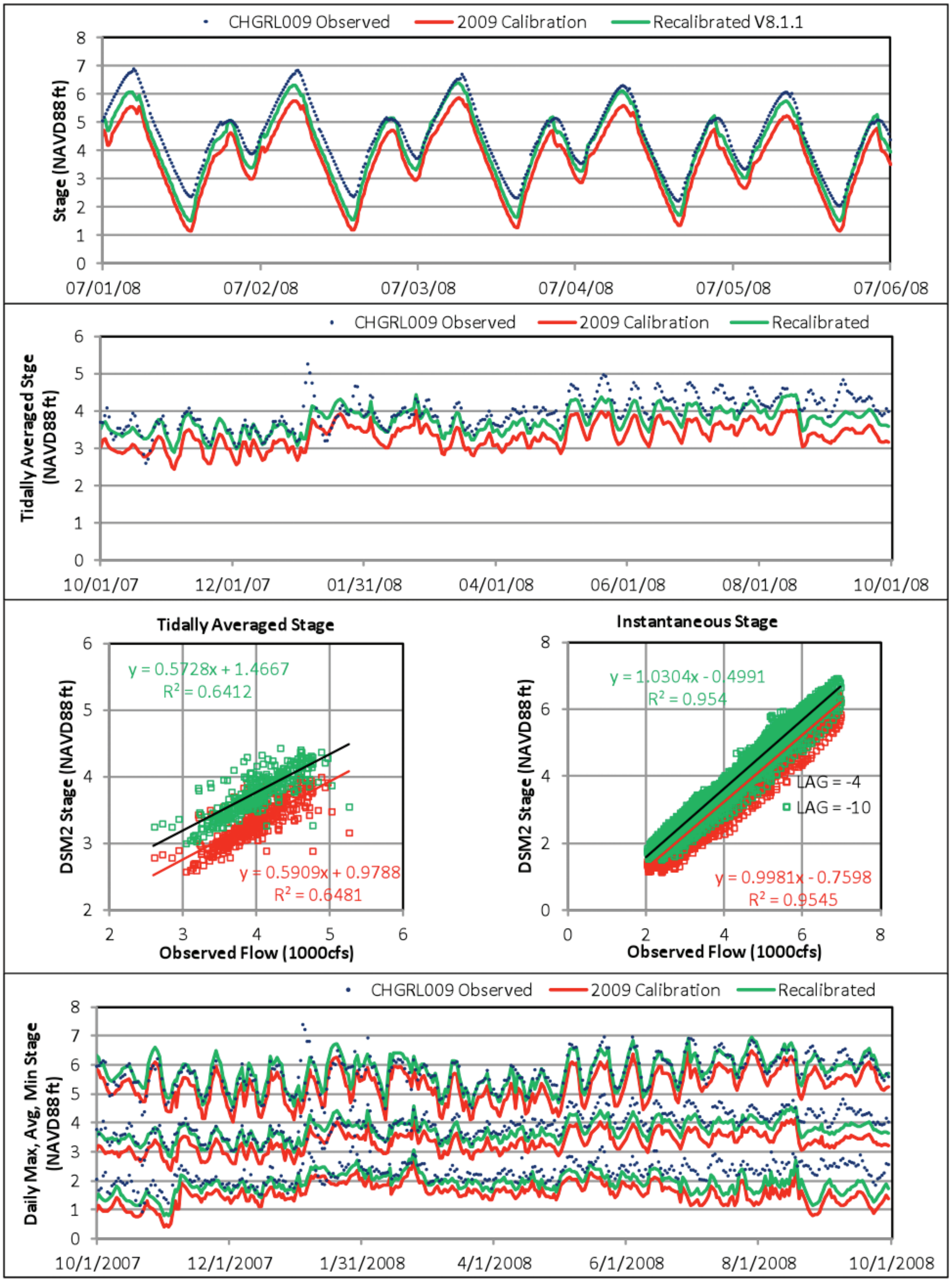


Figure 5. Stage at Grant Line Canal

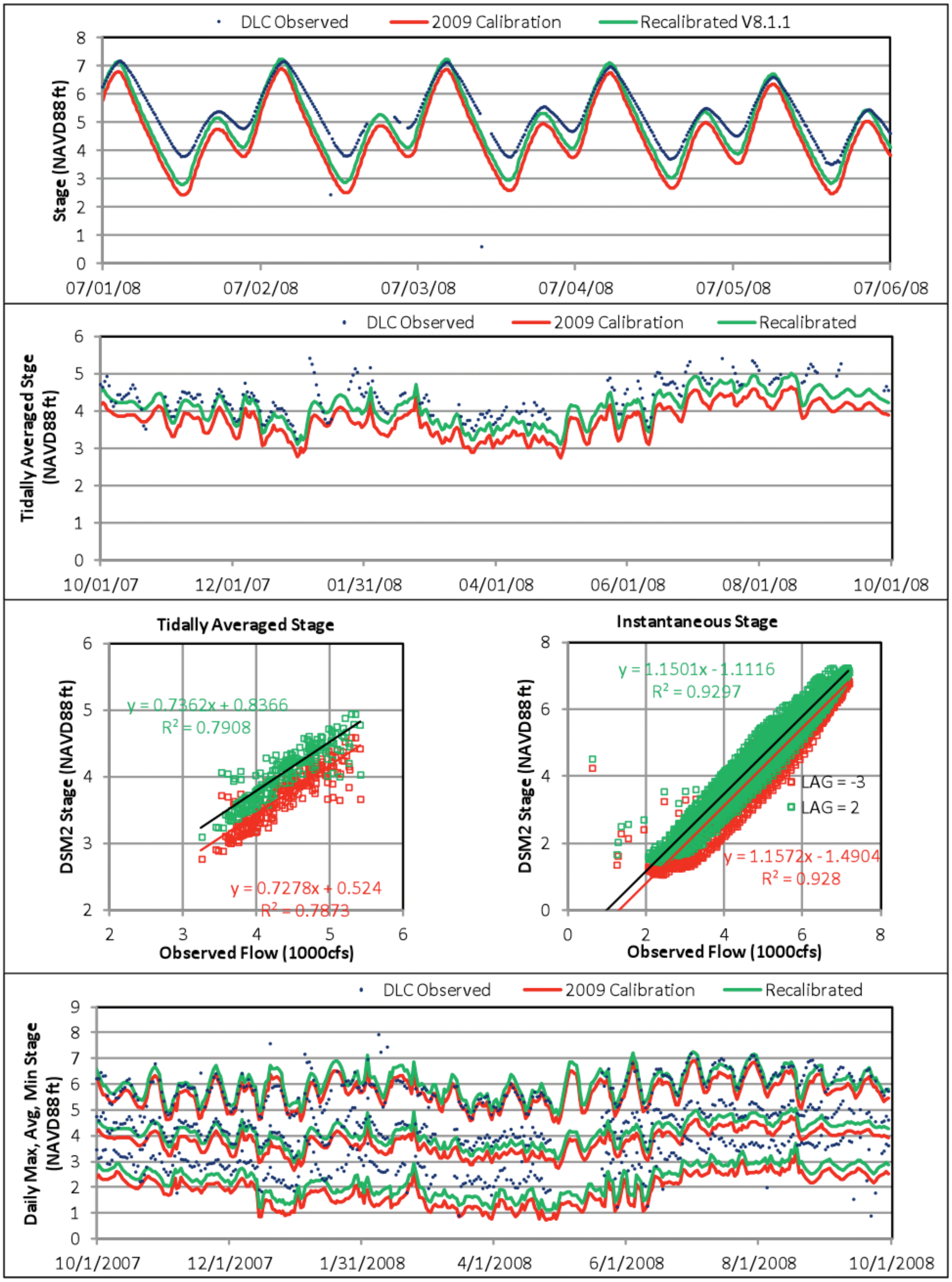
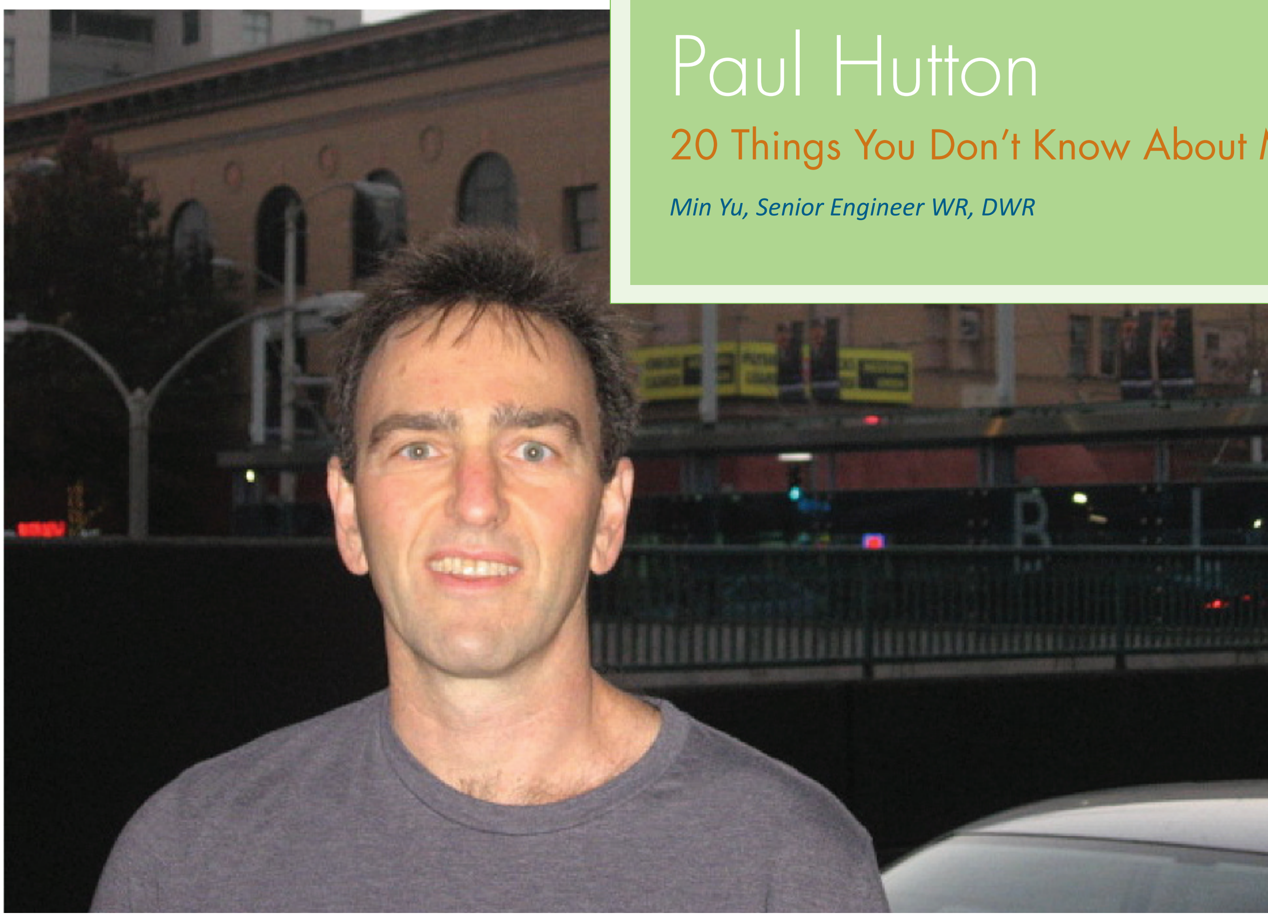


Figure 6. Stage at Delta Cross Channel

DSM2UG People



Paul Hutton

20 Things You Don't Know About Me

Min Yu, Senior Engineer WR, DWR

Paul, a Senior Engineer with the Metropolitan Water District, shares with us 20 tidbits about himself:

1. I grew up in a small town in southern Illinois.
2. Chemistry was my favorite class in high school and early in college. That preference led me in the direction of environmental engineering. In graduate school I took a couple of classes in environmental systems and groundwater modeling that introduced me to simulation and optimization techniques. My love for modeling was born!
3. I took piano lessons from the 1st thru 8th grade.

4. Right after I completed my masters Degree at the University of Illinois at Champaign-Urbana, I moved to Pasadena and began working for Montgomery Engineers at the corporate headquarters (the firm now goes by the name MWH). It was quite a culture shock moving from a small town in the Midwest to southern California.

5. My first major assignment at Montgomery Engineers was to work on a wastewater collection system master plan for Clark County, Nevada, which is essentially the Las Vegas area. I spent a few weeks in Las Vegas with some associates, working by day and attacking casino buffets by night. I also played a little blackjack, enough to see that I shouldn't quit my day job.

6. I began working at DWR in 1990 in the Delta Modeling Section. My favorite assignment during my career with DWR was my last, which was managing an intelligent and hardworking staff as Chief of the Delta Modeling Section.

7. After work, I enjoy spending time with my wife Juliet. We enjoy going for walks, dining out, and watching movies at home. I also like to read.

8. Speaking of reading, my favorite author is John Steinbeck, and my favorite book is "The Grapes of Wrath". I also like Hemingway, Fitzgerald, Raymond Chandler, and the Harry Potter series.

9. I recently retired from my favorite hobby, which is playing basketball. As my children are older and have driver's licenses, I am in search of a new hobby.

10. My wife and I currently live in Elk Grove, but we may move to Vacaville when the children leave home. Vacaville is my wife Juliet's home town.

11. I try to get to the gym on a regular basis to reduce stress. When I am really stressed, I'll usually just go to sleep.

12. My favorite vacations are any that include relaxing on a beach. If I'm sleeping on a beach, that doesn't mean I'm stressed out—it just means I'm really relaxed.

13. I do watch TV, and my favorite programs are *Dexter* and *Saturday Night Live.*

14. We have a pet cat with one good eye and a few good teeth with the intimidating name of Liam Neeson after the actor. My wife picked him up as a stray. I've always considered myself a dog person rather than a cat person, but he's a cat who thinks he is a dog.

15. My favorite cuisine is Thai and I particularly like Thai curries.

16. Comedy is my preferred movie genre; "The Big Lebowski" is my favorite movie.

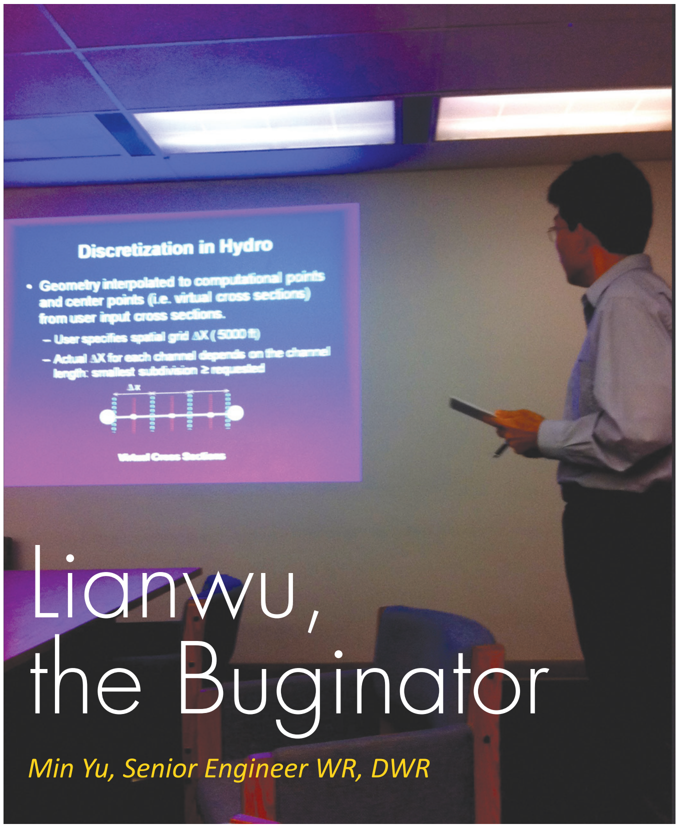
17. The first concert I ever attended was by Three Dog Night in the mid 1970s.

18. Speaking of music, my favorite music genre is blues, followed by rock music from the late 1960s and early 1970s. But I enjoy a wide array of musical styles, except those my children listen to.

19. I am not much a gadgets person, but I certainly love my iPod.

20. There are several things I have on my bucket list, but the three main items are: (1) I want to learn to play golf and will strive to shoot bogie on a regular basis; (2) spend several weeks in Italy in the small town where Juliet lived for a few years as a child; (3) take an extended tour of Israel, Greece, Egypt and Turkey.

Paul receiving Fischer Award in 2006



Lianwu, the Buginator

Min Yu, Senior Engineer WR, DWR

Lianwu presenting at last year's DSM2UG meeting

Lianwu Liu has been an engineer with DWR's Delta Modeling Section since October 2008. I first met him when I phoned to schedule an interview. Even though his resume showcased his extensive education and work experience in water resources engineering, over the phone Lianwu struck me as a man of few words. However, time has certainly proven me wrong.

Lianwu grew up in a small village outside of Tianjin, China. He attended Tianjin University, a top school in China, and obtained his BS in Engineering Mechanics and MS in Computational Fluid Mechanics. In 1995, Lianwu came to USA with a full scholarship to pursue his Ph.D. in Water Resources Engineering at Clarkson University in upstate New York. After graduating he worked for four years as a post-doc Research Scientist and led the model development for the Comprehensive River Ice simulation System Project sponsored by the Canadian Electricity Association and the New York Power Authority. Lianwu still remembers the long hours he spent on this 2-D river-ice model development. Not only did the project require substantial expertise in analytical modeling and computational methods, it required Lianwu have a clear understanding of how ice processes in rivers and ice behavior under stress.

After this experience, Lianwu moved to Tampa Florida where he worked as a Water Resources Engineer for two consulting firms. Both jobs required him to utilize his water resources engineering knowledge, computer modeling experiences, and GIS skills to develop watershed management plans. Reflecting on his work back then, Lianwu admits that, even though he was happy at the time applying what he learned in school, he didn't experience career fulfillment until he joined the Delta Modeling Section.

Lianwu's favorite career assignment began two years ago when he was assigned to conducting systematic testing of DSM2. As many can relate, after being a modeler long enough, one usually develops an 'intuition' which helps identify if the output of a model run is reasonable based on the input. Some of the initial testing results did not make Lianwu's favorite career assignment began two years ago when he was assigned to conducting systematic testing of DSM2. As many can relate, after being a modeler long enough, one usually develops an 'intuition' which helps identify if the output of a model run is reasonable based on the input. Some of the initial testing results did not make senses to him, and Lianwu was determined to find out why. Fortunately Lianwu's strength lies in being meticulous and persistent, and as a result, he has been instrumental in finding 'bugs' in DSM2 ever since. When I asked him how he felt about being DSM2's 'bug finder', he laughed and went into a lengthy exposition of how rewarding this entire experience has been to him. The best part of finding any 'bug', Lianwu says, "is when we fix it".

Outside of the office, Lianwu enjoys his quality time with his baby boy Max. He also is an avid gardener, watching over a carefully designed vegetable garden in his backyard. Just as he does best in his day job, Lianwu is keen on finding and eliminating bugs here too.

Lianwu's vegetable garden

A Tale of One Multidimensional Man

Min Yu, Senior Engineer WR, DWR

Eli next to the Venice Grand Canal, Italy

In Greek, the name **'Eli'** it means 'defender of man'. In America, it means 'high', 'ascended' or 'my God'. While the NFL has its high-performing quarterback Eli Manning, DWR's Delta Modeling Section has its own MVP Eli, namely Eli Ateljevich.

Most people in the modeling community know how brilliant an engineer Eli is, but not everyone may be aware of the path Eli took to become a water resources engineer at DWR. At times I have wondered why Eli, who holds a MS degree in Civil Engineering from MIT and a Ph.D. degree in the same field from UC Berkeley, came to work for a state agency in 2002.

The three things that I knew about Eli before I interviewed him for this article were: 1) Eli is highly intelligent; 2) he is one of the most articulate people I have ever met; and 3) in any dispute, Eli he will eventually convince you he is right and you will agree. Writing about Eli was a daunting task, because he is so multidimensional that it will take more than one page just to list what he enjoys doing. As if being a brilliant engineer is not enough, Eli enjoys a wide variety of hobbies and interests. He calls himself a 'lifestyle guy" and let me tell you what that entails.

Eli's passion for water resources engineering and computer modeling began at 17 years of age when he was a professional rafter on the Kern River in southern California. Somehow that four-year experience triggered a love for California water which would be fulfilled many years later. After high school, Eli studied economics at UC Berkeley for his BS degree. If you know Eli, you understand that Eli would never EVER settle for one thing at one time. While he was passing his exams with flying colors, Eli also played trombone in the UC jazz band and diligently practiced Kung Fu. In the middle of his undergraduate program, Eli decided to drop out of college to travel to Hong Kong to meet an 85-year-old renowned Kung Fu Master he had heard about since he was 7 years old.

Eli spent the next five years in Hong Kong. He met the celebrated Master, learned how to speak Chinese, worked as a temp helper at an art gallery, then tried out modeling (fashion modeling that was), and even was cast for a while in a Chinese TV show. You would think this must have been it for a five-year hiatus for someone who eventually became an engineer. No, not for Eli. Before heading back to the States, Eli pulled his last gig as a journalist and worked at a Chinese law and practice publishing house for another two years.

Eventually, in 1991, Eli found himself back at UC Berkeley continuing his undergraduate program in economics. After he obtained his BS degree in 1993, Eli realized that his true calling was a professional life related to the complex water resources system in California. So Eli attended MIT for the next two years for his MS degree in Civil Engineering, and then in 1995 again returned to UC Berkeley to pursue his Ph.D. in the same field and an incidental masters in statistics. During his Ph.D. program, Eli worked as a research assistant and developed a 1-D model for optimal (minimal water cost) compliance with the water quality standards in the Delta. He also had many opportunities to meet the technical heavyweights in the California water community who strongly influenced his career path. Meanwhile, Eli's enthusiasm in music was expanding. He began playing in a salsa band, performing about three times a week in San Francisco and East Bay clubs.

Eli in a futile attempt to catch up when overtaken by some members of the Davis Cycling Club

Playing at a jazz festival with salsa group Quimbombo

Maybe it was serendipity that when Eli came to Sacramento for the very first DSM2 workshop held about 12 years ago, he met Ralph Finch. Ralph, a Senior Engineer with the Delta Modeling Section, headed DSM2 model development. Ralph had been looking for a solution to a problem concerning model running time and stability. Eli wrote a script to stabilize the model and also change the solver while making the reservoir gate equations be part of the implicit system. These changes greatly sped up the computational performance of DSM2. Ralph offered Eli a job and the rest is history as they say.

Ever since joining DWR, Eli has played a significant role in the R&D team in the Delta Modeling Section. He now is in charge of the development of a multidimensional Bay-Delta model using SELFE (Semi-Implicit Eulerian-Lagrangia Finite-Element) model. The team recently reached a milestone in being able to perform a full Delta model run with operational gates included. The results are very promising. Eli and his team anticipate an official release of SELFE later next year.
In his personal life, Eli has also reached several remarkable milestones in the past 18 months. Not only did Eli meet his soulmate and get married last summer, he and his wife Gina are expecting their first child this October. In addition, they have purchased a home in the Bay Area. Now settling down to family life, he is looking forward to new adventures which will surely come his way.

DSM2UG News

The DSM2UG Portal is Live!

The collaboration portal of the DSM2 User Group is now up and running. The URL is http://dsm2ug.water.ca.gov/. The portal has been developed and implemented using Liferay, an open source software enterprise web platform. Available features include shared calendars, wiki, message board, FAQs, and a library for document share. Future meeting announcements and any news related to DSM2 and DSM2UG will be posted on the main page of the portal. User group members will be given an account with an assigned username and provided contributor's privileges to access the portal for downloads and/or posting messages. We hope the DSM2UG portal will be a community-wide collaboration site for all DSM2 model users and provide group members a new avenue to share timely information.

If you have any questions or comments regarding this issue of the newsletter, please contact the facilitator of the DSM2 User Group:

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This newsletter can be accessed at the DSM2 User Group website:
http://baydeltaoffice.water.ca.gov/modeling/deltamodeling/dsm2usersgroup.cfm